REMARKS

Upon entry of this amendment, claims 1 to 5, 7 to 11, 13 to 17, 19, 20 and 22 to 27 are pending. Reconsideration is hereby requested.

I) AMENDMENTS TO THE CLAIMS AND DESCRIPTION:

Amendments to claims 2, 9, 10, 13, 17 and 19 have been made to better define different aspects of the invention.

Claims 22 to 28 are added to better cover particular aspects of the invention.

a) Amendments to the specification:

The Summary of the invention has been amended to provide a better description of the invention to better correspond to amended claim 1 and new claim 22.

b) Amendments to the claims:

Claim 1 has been amended to avoid the use of the expressions: "upwardly delimited" and "thermal path" which were objected to by the Examiner as being not clear.

Claim 1 has also been amended to better define the invention. More particularly, claim 1 has been amended:

- to include the features of cancelled claim 12 , i.e. that the monophased particles are WC_{1-x} monophased particles;
- to specify that the starting material in step a) is a cast eutectic tungsten semi carbide particles;
- to specify that the particles of the starting material have a particle size ranging from 1 μm and 5 mm, and that the particle size of the final product is similar to the particle size of the starting material. Support for that amendment can be found, for example, on page 12, lines 20 to 22 of the original application. This amendment has been made to highlight the fact that the tungsten

carbide particles subjected to the method according to the invention do not undergo atomization or pulverization. Although, their microstructure undergoes modifications because of steps b) and c), their general global macrostructure remains the same;

- to more clearly define the phase diagram of the WC system. In amended claim 1, the phase diagram is defined as an *equilibrium temperature-composition binary phase diagram plotting temperature against relative concentrations of W and C, said binary phase diagram of the W-C system showing a monophasic domain of an γ solid phase corresponding to WC_{1-x} having a face-centered cubic structure.* Such amendment has been made in order to avoid using the objected expressions "upwardly delimited" and "thermal path";
- to specify that the homogenization treatment is a heat treatment and that the homogenization heat treatment allows to obtain WC_{1-x} monophased particles (i.e. former claim 12);
- to describe more clearly in step c), the final product and what is actually done. More specifically step c) has been amended to recite:
    - that the quenching step is subsequent to the homogenization treatment of step b) ;
    - that the WC_{1-x} monophased particles are subjected to a quenching step to freeze at ambient temperature at least a portion of the face-centered cubic structure and to refine grain size of the microstructure;
    - that the final product has a particle size similar to the particle size of the starting material, a hardness greater than the hardness of the starting material, particles with a finer microstructure than the starting material and a composition comprising at least a portion of face-centered cubic WC_{1-x} structure. Support for this amendment can be found or inferred from the original description, as for example, on page 14, line 28 to page 15 line 2 of the specification.

II) REJECTION UNDER 35 U.S.C. & 112, second paragraph

Claims 1 to 5 and 7 to 21 were rejected under 35 U.S.C. & 112, second paragraph, as being indefinite. The Examiner objects to the two following expressions: "upwardly delimited" and "thermal path". In response thereto, claim 1 has been amended to avoid these two expressions and, as detailed above, step c) of claim 1 has been amended to better define the final product and what is actually done.

With regards to the expression "quenching" used in step c) of claim 1, the Applicants respectfully submit that the expression “quenching” is clear and definite for any person skilled in the art of the invention.

A person skilled in the art of the invention, for example, a metallurgist, will readily understand that in step c), the monophased particles obtained in step b) are quenched, i.e. are rapidly cooled. Indeed, a "quench" refers to a rapid cooling used to prevent low temperature processes such as phase transformations from occurring.

In view of these, the Applicants respectfully submit that claim 1 is clear and definite for any person skilled in the art and a notice to that effect is earnestly solicited.

III REJECTION UNDER 35 U.S.C. &102 (b) and/or 103(a)

Claims 1, 2, 5, 7, 11, 12, 14, 15, 17 and 18 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over RUDY (US 4,066,451). Claims 1, 2, 5, 7, 11, 12, 14, 15, 17 and 18 are rejected under 35 U.S.C. 103(a) as obvious over MOUSTAKAS (US 4,804,583) taken with RUDY, or obvious over KRUSE et al. (US 2002/0112896) taken with RUDY. The Applicants however respectfully submit that amended claim 1 and its subclaims overcome those rejections for the following reasons.

The invention defined in amended claim 1

The invention defined in amended claim 1 concerns a method for treating tungsten carbide particles, comprising the steps of:

a) providing a starting material containing cast eutectic tungsten carbide particles of a given hardness having a particle size ranging from 1 μm and 5 mm and comprising WC and W_2C, said tungsten carbide particles being of a W-C system whose compositions, microstructures and phase distribution are represented on an equilibrium temperature-composition binary phase diagram plotting temperature against relative concentrations of W and C, said binary phase diagram of the W-C system showing a monophasic domain of a γ solid phase corresponding to WC_{1-x} having a face-centered cubic structure;

b) subjecting said starting material to a homogenization heat treatment in said monophasic domain, thereby obtaining WC_{1-x} monophased particles having a face-centered cubic structure; and

c) subsequently to the homogenization treatment of step b), subjecting the tungsten carbide particles to a quenching step to freeze at ambient temperature at least a portion of the face-centered cubic structure and refine grain size of the microstructure, thereby obtaining a final product at ambient temperature containing particles with a finer miscrostructure than the starting material, a particle size similar to the particle size of the starting material, a composition comprising at least a portion of face-centered cubic WC_{1-x} structure and a hardness greater than said hardness of the starting material.

As mentioned, for example on page 11 of the application, line 22 and ss., the presence of the WC_{1-x} phase after quenching, with its face-centered cubic structure, has the advantage of enhancing the mechanical properties of the final product (i.e. as compared to the cast eutectic carbide particles of the starting material) . The presence of the WC_{1-x} phase in the final product is obtained thanks to the fact that the process includes a homogenization heat treatment (step b) in the monophasic domain of the WC_{1-x}. This means that during the homogenization heat treatment, the microstructure

of the two-phase cast tungsten particles of the starting material transforms and rearranges into the face-centered cubic structure of the WC_{1-x}.

Then, due to the quenching step which comes subsequently to the homogenization heat treatment, a portion of the WC_{1-x} face-centered cubic structure freezes (i.e. no phase transformation) at ambient temperature and there is a refinement of the microstructure of the particles. Macroscopically, the particles of the final product, in terms of size, may look relatively the same as the particles of the starting material but they have a microstructure which is different from the microstructure of the particles of the starting material. This "new" microstructure provides the final product with an increased hardness, preferably above 2900HV (as defined in new claim 27).

In a preferred variant of the invention, the properties of the final product can be further improved by subjecting the particles obtained in step b) to a heating treatment above the liquidus line of the monophasic domain, as claimed in claim 2. By doing so, the particles will become spheroid and, as mentioned on page 12, line 6 and ss. of the specification, since the WC_{1-x} phase has the characteristic that it does not decompose during melting, the heating of the particles above the liquidus line will not create the formation of porosity within the product. Indeed, the absence of the decomposition of the WC_{1-x} prevents the formation of pores and promotes greater homogeneity of the final product. The prior art, as discussed below, neither teaches nor suggests the subject matter of claim 1.

RUDY

RUDY teaches and discloses the fabrication of hard two-phase mixtures of subcarbide $(Mo,W)_2C$ and hexagonal monocarbide (Mo,W)C solid solutions by solid state decomposition of pseudocubic, η-$(Mo,W)_3C_2$, or cubic α-$(Mo,W)C_{1-x}$ solid solutions (column 1, lines 35 to 40).

The two-phase mixtures of RUDY are obtained by melt-casting techniques similar to conventional cast tungsten carbide (column 6, lines 47-50).

From column 6, line 47 to column 8, line 3, RUDY discloses the method of fabrication of its carbide alloys. Thereafter, from column 8, line 3, RUDY discloses that the carbide alloys obtained are comminuted to suitable grain size to be combined with alloy binders to provide useful cemented alloys with high wear-resistance.

Hence what has to be compared with the present invention is actually the description of the method of fabrication of the carbides given from column 6, line 47 to column 8. RUDY discloses the fabrication of two types of carbide according to its invention, i.e. Type I and Type II. For each of these two types, a blended powder mixture corresponding to a gross composition of a given $(Mo,W)C_{1-x}$ is provided. The blended powder mixture of RUDY is a mixture of different powders selected from powders of Mo_2C, WC, Mo,W and C, corresponding to a gross composition of $(Mo,W)C_{1-x}$. This mixture of powders is melted (i.e. liquefied) and cast in suitable containers and the solidification product allowed to cool to room temperature (column 6, line 66 to column 7, line 2). RUDY discloses that in the case of the Type II carbides, the X-ray diffraction of the alloy in the as-cast condition shows the presence of subcarbide and hexagonal monocarbide only (column 7, lines 34 to 41).

In the case of Type I carbides, and as disclosed in column 7, lines 14 and ss, the cast piece is heated for a certain time into a graphite container so as to allow the intermediate product to transform into a product showing a phase mixture of subcarbide $(MoW)_2C$ and monocarbide (Mo,W)C.

Therefore in both case of Type I and Type II, a starting powder mixture of different powders selected from powders of Mo_2C, WC, Mo, W and C, corresponding to a gross composition of $(Mo,W)C_{1-x}$ is melted and cast so as to yield a final product showing a two-phase microstructure.

Thus, Applicants respectfully submit that RUDY does not disclose a method for treating tungsten carbide particles. On the contrary, Rudy discloses the fabrication of cast carbide alloys. RUDY does not either disclose the use of cast eutectic tungsten carbide particles as the starting material. The starting material disclosed by RUDY is a mixture of different powders selected from

powders of Mo_2C, WC, Mo, W and C, corresponding to a gross composition of $(Mo,W)C_{1-x}$. The only passages in RUDY where cast tungsten carbides are mentioned (as in Example L of Table 3, or in Table 1) are for the purpose of comparing the alloys of RUDY with the prior art commercial cast carbide.

In addition, RUDY does not disclose a process where the particle size of the treated starting material is similar to the particle size of the final product. The starting material of RUDY is a powder mixture and the final product is a cast block which after comminution to a suitable grain size can be combined with alloy binders (see column 8, line 4 to 8).

RUDY does not either disclose a homogenization heat treatment in the γ solid phase monophasic domain of WC_{1-x} as defined in step b) of claim 1 of the present invention.

On the contrary, RUDY teaches to directly melt (liquid form) the powder mixture. Therefore RUDY does not disclose or suggest a homogenization heat treatment in the monophasic domain.

In view of these, the Applicants submit that the process of RUDY is very far from the method defined in amended claim 1, and as such amended claim 1 is believed to be novel and inventive over RUDY.

MOUSTAKAS and KRUSE

The characteristics mentioned above which are lacking from RUDY are neither taught nor suggested by MOUSTAKAS nor KRUSE.

MOUSTAKAS discloses the deposition of fine layers of tungstene carbide by RF diode sputtering, i.e. by pulverizing a target. The sputtered atoms of the target are deposited on a substrate to form thin layers having a thickness in the range of 5A to 1000A. MOUSTAKAS does not disclose a method of treating particles having a particle size ranging from 1 μm and 5 mm and a final product having a particle size similar to particle size of the starting material. MOUSTAKAS does not either teach a homogenization heat treatment in the above described monophasic domain of WC_{1-x}.

KRUSE does not disclose a homogenization heat treatment in the monophasic domain of WC_{1-x}. KRUSE teaches a grinding step and not a heating step, and KRUSE never refers to a treatment in the monophasic domain of WC_{1-x}.

Therefore the combination of RUDY with MOUSTAKAS and/or KRUSE cannot result in the method defined in claim 1. In other words a person in the art having knowledge of these three prior art references would not have been led to the method of amended claim 1.

The Examiner is requested to withdraw the rejection of claims 1 and its sub-claims under 35 U.S.C. &102 (b) and/or 103(a) and allow these claims.

IV) REJECTION UNDER 35 U.S.C. & 102 (a) and/or 103(a)

Claims 17 and 19 were rejected under 35 U.S.C. 102(a) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over CHRISTIAN (US 6,551,569). The Examiner also rejected claims 19 and 20 under 35 U.S.C. 103(a) as being unpatentable over the DUNMEAD (US 5,746,803). In response thereto, claim 17 has been amended to include that the tungsten carbide particles have a particle size ranging from 1 μm and 5 mm.

CHRISTIAN discloses a tungsten carbide material consisting of extremely small crystallites in the order of about 15 to about 30 angstroms in size. The Applicants respectfully submit that this has nothing to do with the particles defined in claim 17, which has a particle size ranging from 1 μm and 5 mm.

The Applicants thus respectfully submit that amended claim 17 is novel and inventive over CHRISTIAN.

In response to the rejection of claim 19 as being obvious over DUNMEAD, claim 19 has also been amended to include that the particles have a particle size ranging from 1 μm to 5 mm.

DUNMEAD teaches a powder having a particle size of less than about 0,4 μm. It is thus respectfully submitted that amended claim 19 is inventive over DUNMEAD.

Now claims 22-26 also are directed to the method that has the quenching step. These claims also should be allowed. Now claims 27-29 depend from claim 1 and should be allowable for the reasons given above.

This application is believed to be in condition for allowance, which is earnestly solicited. If the Examiner believes that there are further issues that could be advanced by an interview or an entry of Examiner's amendment, the Examiner is invited to contact the undersigned attorney.

In view of the above amendment, applicant believes the pending application is in condition for allowance.

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Respectfully submitted,

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